THE APPLICATION OF FLUORESCENT CRYSTAL COUNTERS TO DISINTEGRATION STUDIES

BY

ROBERT STUMP

B.A., Butler University, 1942
M.S., University of Illinois, 1948

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN PHYSICS
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UNIVERSITY OF ILLINOIS, 1950

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The use of fluorescent crystal counters as detectors of nuclear radiations has become widespread recently. The characteristics of these counters are discussed in this thesis, and there are described several experimental nuclear studies in which the unique properties of crystal counters are desirable.

Equipment which extends the field of usefulness of crystal counters is described. Primarily, this includes the components of a β-γ scintillation spectrograph, which are as follows:

1. Regulated high voltage supply
2. Non-overloading linear amplifier
3. Single channel pulse height selector
4. Coincidence circuit.

The nuclear disintegration studies reported in this thesis include measurements of β-γ angular correlations, and the first β-γ polarization correlation to be measured. Also we describe the work leading to the establishment of the decay schemes for Sn^{117m}, Sn^{123}, and Rb^{86}.

A brief summary of the β-γ angular correlation theory together with the results of measurements of Au^{198}, Cb^{95}, Cs^{134}, and Rb^{86} is given. The measurements on Au^{198}, Cb^{95}, and Cs^{134} are consistent with an isotropic distribution of γ-rays with respect to the β direction. The isotropy in Cs^{134} is further verified by biasing the β detector to detect only the upper 7% of the β spectrum. With this arrangement, again no anisotropy is observed. The β-γ angular correlation of Rb^{86} is shown to be of the form $W(\theta) = 1 + R/Q\cos^2\theta$ with $R/Q = .057 \pm .01$.

Since a β-γ angular correlation exists in Rb^{86}, there is also

a β-γ polarization correlation. This effect is analogous to the γ-γ polarization effect described by Hamilton. A summary of the theory of the β-γ polarization correlation and the theory of the detection of this effect is presented. A β-γ polarization correlation is observed in Rb^{86}, and the results of the measurement indicate that the γ-ray in the decay of Rb^{86} is emitted with a change in parity.

In order to complete the studies on the decay of Rb^{86}, β ray spectrographic measurements are described. It is shown that the high energy spectrum of Rb^{86} has a shape given by the factor $(p^2 + q^2)^{\frac{1}{2}}$ in the formula for the spectral distribution. The low energy spectrum, measured in coincidence, appears to have an allowed shape, although the data are not sufficiently accurate to detect small deviations. It is shown by means of the coincidence data that the β-γ branch of the decay of Rb^{86} accounts for only about 15% of the transitions.

On the basis of the angular correlation, polarization correlation, and spectrum studies on Rb^{86}, a brief discussion of the decay scheme for this nucleus is presented.

The decay schemes of Sn^{117m} and Sn^{123} are established. By critical absorption and coincidence absorption measurements, it is shown that Sn^{117m} decays to the ground state of Sn^{117} by the emission of two γ-rays in cascade. The 130-day activity of Sn^{123} is shown to consist of a single β transition directly to the ground state of Sb^{123}. The shape of the β spectrum is that given by the factor $(p^2 + q^2)^{\frac{1}{2}}$.

VITA

Robert Stump was born on October 16, 1921, in Indianapolis, Indiana. He attended the public schools there, graduating from Shortridge High School in 1939. He entered Butler University in 1939, and received the degree of Bachelor of Arts, Magna Cum Laude, in 1942. In 1942, after two months of graduate work at the University of Illinois, he enlisted in the Army of the United States. His Army experience included training in Meteorology at New York University, and in Maritime Meteorology and Oceanography at the University of California at Los Angeles. After his discharge from the Army in 1946, he re-entered the Graduate College of the University of Illinois, receiving the degree of Master of Science in 1948. He held a Teaching Assistantship from September, 1946 to June, 1949, and an Atomic Energy Commission Predoctoral Fellowship thereafter.